

SECTION 31 00 00

EARTHWORK

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Staking and grades
- B. Existing utilities
- C. Earthwork general requirements
- D. Subsurface extraction
- E. Rough grading and filling
- F. Excavation
- G. Embankment construction
- H. Subgrade preparation
- I. Foundation preparation
- J. Subgrade filling/raising grade
- K. Compaction
- L. Backfilling
- M. Finish grading
- N. Field quality control

1.02 RELATED SECTIONS

- A. Dewatering is specified in Section 31 23 19, Dewatering.
- B. Shoring and underpinning are specified in Section 31 40 00, Shoring and Underpinning.
- C. Excavation support systems are specified in Section 31 50 00, Excavation Support and Protection.
- D. Excavating and backfilling for subsurface drainage and utilities are specified in Section 33 05 28, Trenching and Backfilling for Utilities.
- E. Aggregate drainage fill is specified in Section 32 11 24, Aggregate Drainage Layer

- F. Drainage and filter aggregates and permeable material for subsurface drainage are specified in Section 33 46 00, Sub drainage.
- G. Aggregate sub base is specified in Section 32 11 17, Aggregate Sub base Courses.
- H. Aggregate base course is specified in Section 32 11 23, Aggregate Base Course.

1.03 MEASUREMENT AND PAYMENT

- A. General: Measurement and payment for earthwork will be either by the lump-sum method or by the unit-price method as determined by the listing of the bid items for earthwork indicated in the Bid Schedule of the Bid Form.
- B. Lump Sum: If the Bid Schedule indicates a lump sum for earthwork, the lump-sum method of measurement and payment will be in accordance with Section 01 20 00, Price and Payment Procedure, Article 1.03.
- C. Unit Prices
 - 1. Measurement Method: If the Bid Schedule indicates unit prices for earthwork, the unit-price method of measurement and payment will be in accordance with the following requirements.
 - 2. Measurement Unit: The following classifications of work will be measured for payment by the cubic yard unless otherwise indicated:
 - a. Excavation - Common;
 - b. Excavation - Rock;
 - c. Structure Excavation;
 - d. Structure Backfill;
 - e. Fill for Raising Grade;
 - f. Pervious Backfill;
 - g. Common Embankment;
 - h. Select Embankment; and
 - i. Subsurface Extraction.
 - 3. Measurement for Payment of Excavations, Fill, Backfill, and Embankment:
 - a. Excavations will be measured for payment by the cubic yard, and quantities will be computed, based on the neat lines or pay lines, section profiles, contours, and dimensions indicated on the Contract Drawings.
 - b. Fill for raising grade, backfill, embankment, and pervious backfill, including placement and compaction, will be measured by the cubic yard in place, and quantities will be computed, based on the neat lines or pay lines, section profiles, finish grades, and dimensions indicated on the Contract Drawings.

- c. The upper limit for payment of excavations shall be the ground surface as it existed prior to the start of construction operations.
 - d. The upper limit for payment of backfill, when not indicated, shall be the ground line at the time the excavation is made; except the upper limit for fill shall be the finished grade indicated.
 - e. The lower limits for computing pay quantities of excavation and backfill shall be a plane at the bottom of the completed footings or structures. The lower limit of fill shall be the existing grade at start of construction or the excavated bottom as indicated.
 - f. Salvaging of topsoil will be classified and measured as Excavation - Common.
4. Measurement for payment of Subsurface Extraction:
- a. The volumes of structures, the removal of which is measured and paid for as subsurface extraction, will be deducted from the quantities of excavation computed as herein specified.
 - b. Subsurface extraction will be measured for payment by the lump sum, cubic yard, linear foot for pipelines, or other appropriate unit as listed in the Bid Schedule of the Bid Form.
 - c. If no pay item is provided in the Bid Schedule for the removal of a subsurface man-made object, the removal and disposal of such object will be paid for at the Contract unit price applicable to the excavation in which the item is encountered.
 - d. If the presence of the object is not indicated in the Contract Documents, and its presence could not have been detected by visual inspection, the removal and disposal of the item will be paid for as Differing Site Conditions as specified in the General Conditions, Article GC4.6.
5. Items Not Measured for Payment:
- a. Compacting original ground or scarified sub grade will not be measured separately for payment, and all costs in connection therewith will be considered incidental to the material or structure to be placed or constructed on the compacted original ground or sub grade.
 - b. Sub grade and bearing-foundation preparation will not be measured separately for payment, and all costs in connection therewith will be considered incidental to the material or structure to be placed or constructed on the sub grade or bearing foundation.
 - c. Re-handling of stockpiled material will not be measured separately for payment, but will be considered incidental to the earthwork to which it pertains.
 - d. Borrow excavation will not be measured separately for payment, but will be included in the costs for fill and backfill materials.

6. Payment: Payment for earthwork will be made at the Contract unit prices for the computed quantities as determined by the measurement methods specified herein. Payment will be made only for items listed in the Bid Schedule of the Bid Form. All other work will be considered incidental to and included with the Bid Items.

1.04 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM C131 Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
2. ASTM C136 Test Method for Sieve Analysis of Fine and Coarse Aggregates
3. ASTM C535 Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
4. ASTM D422 Method for Particle-Size Analysis of Soils
5. ASTM D653 Terminology Related to Soil, Rods, and Contained Fluids
6. ASTM D1140 Test Method for Amount of Material in Soils Finer Than the 200 (75-um) Sieve
7. ASTM D1557 Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in. (457-mm) Drop
8. ASTM D2216 Test Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures.
9. ASTM D2487 Test Method for Classification of Soils for Engineering Purposes
10. ASTM D2974 Test Method for Moisture, Ash, and Organic Matter of Peat and Other Organic Materials
11. ASTM D4253 Test Methods for Maximum Index Density of Soils Using a Vibratory Table
12. ASTM D4254 Test Methods for Minimum Index Density of Soils and Calculation of Relative Density
13. ASTM D4318 Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

14. ASTM D6938 Standard Test Method for In-place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

B. State of California, Department of Transportation (CalTrans), Standard Test Methods:

1. Calif. Test 217 Method of Test for Sand Equivalent

1.05 DEFINITIONS

- A. Earthwork Terminology: Terms used in this Section and not defined herein shall be interpreted in accordance with the definitions given in ASTM D653.
- B. Soil Classification: Soil classification is based on the Unified Soil Classification system given in ASTM D2487. Group symbols, when used, conform with the symbols of ASTM D2487.
- C. Fill: Soil or soil-rock material placed to raise the subgrade or natural grade of the site.
- D. Backfill: Soil or soil-rock material used to backfill excavations and to backfill excavated spaces around foundation walls, building walls, retaining walls, head walls, and abutments.
- E. Embankment: Soil or soil-rock material for embankment construction. Embankment construction includes constructing embankments and dikes, including the preparation of the areas upon which they are to be placed; and the construction of temporary surcharge embankment above the grading plane.
- F. Borrow: Soil or soil-rock material used for fill, backfill, embankment, or other construction that is excavated from an off-site location and hauled in.
- G. Unsuitable Material: Excavated material or material below the natural ground surface in embankment areas or below sub grade elevation in excavated areas, which is unsuitable for its planned use. Unsuitable material is further defined as material determined to be:
 - 1. Of such unstable nature as to be incapable of being compacted to specified density using ordinary methods at optimum moisture content; or
 - 2. Too wet to be properly compacted and circumstances prevent suitable drying prior to incorporation into the work; or
 - 3. Otherwise unsuitable for the planned use.

The presence of excessive moisture in a material is not, by itself, sufficient cause for determining that the material is unsuitable. The existence of unsuitable material may be indicated in the Contract Documents or may be determined by the Engineer during the progress of the work.

- H. Relative Compaction: The ratio, expressed as a percentage, of the in-place dry density of material as compacted in the field to the maximum dry density of the same material as determined by laboratory test ASTM D1557.
- I. Optimum Moisture Content: The water content at which a soil can be compacted to a maximum dry unit weight by a given compactive effort.
- J. Relative Density: Mass per unit volume as specified in ASTM D4253 and ASTM D4254, as applicable to the soil and test method employed.

1.06 CLASSIFICATION OF EARTHWORK

- A. For specification purposes, earthwork shall be classified as follows:
 - 1. Excavation-Common: All excavation involved in grading and construction of the trackway, parking areas, landscaped areas, walkways, roads, driveways, and connections thereto; and any other excavation classified or indicated as common excavation.
 - 2. Excavation - Rock: Includes removal of material in place which cannot be loosened or broken down with one pass of a crawler tractor weighing not less than 55,000 pounds, with a maximum draw-bar pull of not less than 57,000 pounds-force, pulling a single 24-inch hydraulic ripper tooth approved by the tooth manufacturer for use with the tractor under full hydraulic down pressure, or equipment of equivalent ripping capacity.
 - 3. Structure Excavation: The removal of material for the construction of foundations for aerial structures, bridges, buildings, retaining walls, headwalls, cut-and-cover subways, and other structures, and such other excavation indicated as structure excavation.
 - 4. Structure Backfill: Structure backfill includes furnishing structural fill material, and placing and compacting structural fill material around structures to the lines and grades indicated. Structure backfill includes borrow excavation and material when required.
 - 5. Fill for Raising Grade: Includes raising of sub grade or grade to indicated elevation with structural fill, including moisture-conditioning and compaction of placed fill material. Structural fill material includes borrow excavation and material when required.
 - 6. Pervious Backfill: Includes furnishing, placing, and compacting pervious backfill material behind abutments, wingwalls, and retaining walls, as indicated.
 - 7. Common Embankment: Used only for embankment construction, above surrounding grade, below 2.5 feet of the finished embankment grade or sub grade, and where there are no foundation-bearing concrete structures above. Common embankment includes borrow excavation material when required.

8. Select Embankment: Used only for embankment construction, above surrounding grade, within 2.5 feet of the finished embankment grade or sub grade. Select embankment includes borrow excavation material when required.
9. Subsurface Extraction: Includes removal of abandoned utilities, tanks, walls, foundations, and other miscellaneous subsurface man-made structures that interfere with new construction and are designated to be removed, and the cleaning of such items if they are indicated to be salvaged. Removal of such obstructions at or above grade is specified in Section 02 41 00, Demolition.
10. Salvaging Topsoil: Salvaging topsoil is the removal of topsoil to the depth indicated, stockpiling the material on-site, and maintaining the stockpile until the material is reused in the work. Salvaging of topsoil shall be classified the same as the excavation with which it is associated, but if no such classification can be made, it shall be classified as Excavation - Common.

1.07 DESCRIPTION

- A. Provide excavation for trackway and pavement; excavation and placement of compacted fill and backfill for structures, cut-and-cover subways, and subsurface and surface drainage; placement of pervious backfill; construction of embankments; sub grade and foundation preparation; subsurface extraction of miscellaneous structures and facilities indicated or required to be removed; and finish grading.

1.08 SUBMITTALS

- A. General: Refer to Section 01 33 00, Submittal Procedures, and Section 01 33 23, Shop Drawings, Product Data, and Samples, for submittal requirements and procedures.
- B. Quality Plan: Refer to Section 01 43 00, Quality Assurance, and Section 01 45 00, Quality Control, for general requirements. The Quality Plan shall include a schedule of all tests specified to be performed by the Contractor.
- C. Test Reports: Submit certified test reports of all tests specified to be performed by the Contractor. Test reports shall be sealed and signed by a California registered geotechnical engineer when required to meet requirements of the California Building Code, Chapter 33, and Appendix Chapter 33, and Structural Chapters 18 and 18A.
- D. Samples: Furnish and deliver samples of fill and backfill materials as selected by the Engineer for testing and analysis.
- E. Delivery Tickets: Submit a delivery ticket with each load of imported borrow material delivered to the site, stating the type of fill material and the quantity.
- F. Field Verification for In-Situ Treatment: Submit the proposed program for field verification of Standard Penetration Test "N" Values after in-situ treatment for mitigation of liquefaction potential.

1.09 REGULATORY REQUIREMENTS

- A. Regulatory requirements that govern the work of this Section include the following governing codes:
 - 1. California Code of Regulations, Title 8, Chapter 4, Subchapter 4 — Construction Safety Orders, and Subchapter 19 — Trench Construction Safety Orders.
 - 2. California Code of Regulations, Title 24, Part 2, California Building Code, Chapter 33 and Appendix Chapter 33, and Structural Chapters 18 and 18A.

1.10 QUALITY CONTROL

- A. Quality Plan: The Contractor shall submit a Quality Plan, conforming to the requirements of Section 01 43 00, Quality Assurance, and Section 01 45 00, Quality Control, covering all earthwork operations and the field quality control to be performed by the Contractor.
- B. Quality Control: The Contractor shall provide proper quality control measures to assure compliance with specified requirements. Foundation and sub grade preparation and the placement and compaction of fills shall be performed under the surveillance of a California registered geotechnical engineer employed by the Contractor, as required to comply with the California Building Code, Chapter 33 and Appendix Chapter 33 and Chapters 18 and 18A.
- C. Tests: The Contractor shall engage the services of an approved independent soils testing laboratory to perform tests.
- D. Tolerances:
 - 1. Construct finished surfaces to plus or minus 1/2-inch of the elevations indicated.
 - 2. Complete embankment slopes to plus or minus 6 inches of the slope line indicated. Do not encroach on the trackway bed or roadbed.
 - 3. Maintain the moisture content of fill material as it is being placed within plus or minus two percent of the recommended moisture content of the material.

1.11 SITE CONDITIONS

- A. Unfavorable Weather Conditions:
 - 1. Excavating, filling, backfilling, and grading work shall not be performed during weather conditions which might damage or be detrimental to the condition of existing ground, in-progress work, or completed work. When the work is interrupted by rain, excavating, filling, backfilling, and grading work shall not resume until the site and soil condition (moisture content) are suitable for compaction.
 - 2. Sub grade shall be free from mud, snow, ice, and deleterious material when work is resumed.

3. Soil material that is too wet for compaction shall be left to drain, to be aerated and dried by disking and harrowing or other approved methods until the moisture content of the area is uniform and within the specified limits.
- B. Prevention of Erosion: Comply with requirements specified in Section 01 57 00, Temporary Controls, and the following:
1. Prevent erosion of stockpiles, ditches, embankments, filled, backfilled, and graded areas until such time as permanent drainage and erosion control measures have been installed.
 2. Perform "protective grading" to provide positive drainage and to minimize ponding of surface water.

PART 2 – PRODUCTS

2.01 FILL AND BACKFILL MATERIALS - GENERAL REQUIREMENTS

- A. Material used for fill, backfill, and embankment construction shall be an inert, inorganic soil, free from deleterious substances, and of such quality that it will compact thoroughly without the presence of voids when watered and rolled. (Inorganic soil is defined as soil containing less than two percent by weight of organic material when tested in accordance with ASTM D2974.) Excavated on-site material will be considered suitable for fill, backfill, and embankment construction if it is free from organic matter and other deleterious substances and conforms to the requirements specified herein.
- B. Excavated material that is suitable for fill, backfill, and embankment construction shall be conditioned for reuse and properly stockpiled for later filling and backfilling operations. Conditioning shall consist of spreading material in layers not to exceed 8 inches and raking free of debris and rubble. Rocks exceeding 6 inches in largest dimension and deleterious material shall be removed from the site and disposed of as specified herein under Disposal of Surplus Material.
- C. Where conditions require the importing of fill or backfill material, the material shall be an inert soil or soil-rock material free of organic matter and meeting or exceeding the minimum requirements specified herein for the location.
- D. All material to be used for filling, backfilling, and embankment construction requires written approval of the Engineer.

2.02 FILL AND BACKFILL MATERIALS - SPECIFIC REQUIREMENTS

- A. Common Fill: Well-to moderately well-graded soils consisting of sands, silts, and clays, with or without gravel, as excavated, screened or blended, having the following mechanical properties and gradation:

1. Gradation (ASTM D422):

Sieve Opening	Percent Passing, by Weight
6-inch square	100
3/4-inch square	70 minimum

2. Liquid Limit (ASTM D4318): 50 maximum

3. Plasticity Index (ASTM D4318): 25 maximum

B. Common Embankment: Common fill, with the following additional requirements:

1. Liquid Limit (ASTM D4318): 40 maximum

2. Plasticity Index (ASTM D4318): 15 maximum

C. Select Embankment: Well-to moderately-graded soils consisting of sands, silts, and clays, with or without gravel, as excavated, screened or blended, having the following mechanical properties and gradation:

1. Gradation (ASTM D422):

Sieve Opening	Percent Passing, by Weight
1 inch square	100
3/8 inch square	75 minimum
U.S. No. 4	20 minimum
U.S. No. 200	35 maximum

2. Sand Equivalent (Calif. Test 217): 10 minimum

3. Plasticity Index (ASTM D4318): 10 maximum

D. Structural Fill: Well to moderately-graded granular soils, as excavated, screened or blended, having the following mechanical properties and gradation:

1. Liquid Limit (ASTM D4318): 25 maximum

2. Plasticity Index (ASTM D4318): 6 maximum

3. Gradation (ASTM D422):

Sieve Opening	Percent Passing, by Weight
3 inch square	100
U.S. No. 4	35 minimum
U.S. No. 30	20 minimum

EARTHWORK

U.S. No. 200 25 maximum

4. Sand Equivalent (Calif. Test 217): 20 minimum

- E. Pervious Backfill: Clean washed gravel or crushed stone, natural sands, manufactured sand, or combination thereof, conforming to the following requirements:

1. Gradation (ASTM C136):

Sieve Opening	Percent Passing, by Weight
2 inches square	100
U.S. No. 50	0-100
U.S. No. 100	0-8
U.S. No. 200	0-4

2. Percentage wear

(ASTM C131 or C535): 50 percent maximum

3. Soft fragments as a function of percent wear: 15 percent maximum

4. Coal and lignite: 0.25 percent maximum

5. Clay Lumps: 0.25 percent maximum

6. Other deleterious material: 2.0 percent maximum

2.03 MATERIALS FOR EARTHWORK

- A. Fill and Backfill Materials: Where specific fill, backfill, and embankment materials are not indicated on Contract Drawings, conform to the following requirements:

1. Embankment: Common embankment below 2.5 feet for finished sub grade; select embankment for top 2.5 feet of finished sub grade.
2. Fill for Raising Grade: Structural fill beneath foundations and for sub grade below structures. Fill for raising grade under pavements and trackways shall be sub base material as specified in Section 32 11 17, Aggregate Sub base Courses.
3. Backfill Against Concrete Walls and Waterproofing: Structural fill or pervious backfill as indicated.
4. Backfill for Wing Walls, Retaining Walls, and Abutments: Structural fill or pervious backfill as indicated.

5. Fill or Backfill Under Supporting Walls and Columns and Similar Locations:
Class 4000 concrete.

6. Backfill Where Not Otherwise Indicated: Common fill.

- B. Topsoil to be Salvaged: Only existing topsoil which meets the requirements of Section 32 90 00, Planting, shall be salvaged. Topsoil that does not meet requirements specified in the Landscape Planting Section of the Contract Specifications shall be classified as Unsuitable Material and shall be removed from the site as herein specified under Disposal of Surplus Material.

2.04 SOURCE QUALITY CONTROL

- A. Fill, backfill, and embankment materials proposed to be used in the work shall be tested in the laboratory for compliance with specified requirements as follows:
1. Moisture-Density Relationship: ASTM D1557.
 2. Moisture Content: ASTM D2216.
 3. Liquid Limit: ASTM D4318.
 4. Plastic Limit and Plasticity Index: ASTM D4318.
 5. Percentage of Wear: ASTM C131 or C535 as applicable.
 6. Sieve Analysis: ASTM D422, and ASTM C136, as applicable.
 7. Percent Passing No. 200 sieve: ASTM D1140.
 8. Sand Equivalent: California Test 217.
 9. Organic Content of Soils: ASTM D2974.
- B. Where classification of soils is necessary to meet specified requirements, perform laboratory tests in accordance with ASTM D2487.
- C. Submit certified test reports of all tests as herein specified under Submittals.
- D. Provide samples as requested by the Engineer for preparing checklists. Provide three samples of each type of material proposed for use from locations selected by the Engineer.

PART 3 – EXECUTION

3.01 STAKING AND GRADES

- A. Lay out the work, establish all necessary markers, bench marks, grading stakes, and other stakes as required, in accordance with the requirements specified in Section 01 71 23, Field Engineering.

- B. Install settlement markers at locations and elevations as determined by the Engineer. Comply with the requirements of Section 31 09 00, Geotechnical Instrumentation and Monitoring of Earthwork.

3.02 EXISTING UTILITIES

- A. Verify on site the location and depth (elevation) of all existing utilities and services before performing any excavation work. Refer to Section 33 05 25, Support and Protection of Utilities, for additional requirements. Excavation within 3 feet of an active utility line shall be performed by hand.
- B. Abandoned sewers, piping, and other utilities encountered in the progress of the excavating shall be removed and the ends plugged.
- C. Active utility lines encountered, which are not indicated in the Contract Documents, shall be reported immediately to the Engineer and utility owners involved. The Engineer and utility owners shall be permitted free access to determine the measures deemed necessary to repair, relocate, or remove the utility.

3.03 EARTHWORK GENERAL REQUIREMENTS

- A. Dust Control: Refer to Section 01 57 00, Temporary Controls, for dust control requirements.
- B. Erosion Protection: Prevent erosion of the site at all times. Construct temporary berms and dikes and cut temporary swales to promote natural drainage of site. Refer to Section 01 57 00, Temporary Controls, for additional requirements.
- C. Construction Traffic: Disperse travel paths of traffic and construction equipment over entire width of compacted surfaces so as to aid in obtaining uniform compaction. Protect exposed soil layers with high moisture content from excessive wheel loads.
- D. On-Site Excavation or Borrow Pits: Do not excavate or remove any material from the project site or right-of-way which is not within the designated excavation, as indicated by the slope and grade lines, without written authorization from the Engineer.
- E. Salvaging Topsoil:
 - 1. Salvage topsoil from stripped and excavated areas, and stockpile on the site at appropriate locations. Prevent topsoil from contamination by other materials, and provide adequate drainage and erosion protection.
 - 2. Place stockpiled topsoil in areas to be landscaped as indicated on the Contract Drawings.
- F. Stockpiling of Fill and Backfill Material:

1. Excavate and separately stockpile suitable fill and backfill material, as indicated, during the progress of the excavation work. Save sufficient suitable excavated material, if available, for later filling, backfilling, and embankment construction.
2. Store materials from required excavations that are suitable for fill, backfill, and embankment as excavated, in stockpiles segregated by type.
3. Establish excavated material stockpiles on site only in locations where they will not interfere with the progress of the work. Offsite stockpiling, if necessary, shall be the responsibility of the Contractor.

G. Disposal of Surplus Material:

1. Excess earth materials, unsuitable materials, and debris shall become the property of the Contractor and shall be removed from the site and disposed of in a legal manner.
2. Location of disposal site and length of haul shall be the Contractor's responsibility.

H. Maintenance of Excavations, Slopes, and Embankments:

1. Excavate and remove material outside the limits of the excavation which is unstable and constitutes potential slides, and material which comes into excavations for any reason including from the driving of piles.
2. Maintain slopes and embankments until substantial completion and acceptance of the work. Promptly repair slides, slipouts, washouts, settlements, and subsidences that occur for any reason, and refinish the slope or embankment to the indicated lines and grades.
3. Refer also to Section 31 35 00, Slope Protection, for requirements.

- I. Safeguarding of Structure Walls: Heavy equipment and rollers greater than one ton shall not be operated within 4 feet of structure walls.

3.04 SUBSURFACE EXTRACTION

- A. Remove subsurface facilities and obstructions to the extent indicated.
- B. When subsurface facilities are encountered during excavation which interfere with new construction, and such facilities are not indicated, notify the Engineer promptly for corrective determination.

3.05 ROUGH GRADING AND FILLING

- A. Prior to commencement of earthwork, perform such soil and rock removal and filling as may be required to facilitate the progress of the work and bring all elevations to the rough grading lines indicated on the Contract Drawings. Grading shall be performed by blading or as herein specified under Article 3.08.

- B. Fill or backfill, test pits, or holes which will not be completely removed by excavation, with lean concrete, pervious backfill, or clean structural fill, and compact as herein specified in layers not exceeding 8 inches in uncompacted thickness.
- C. Fill or backfill holes, swales, and low points that will not otherwise be removed in the course of the work to the indicated grades.

3.06 EXCAVATION

- A. General Excavation Requirements:
 - 1. Perform excavating as indicated and required for trackway and roadway beds, for concrete footings, foundations, retaining walls, exterior paving, floor slabs, concrete walks, and for site levels and grading, and provide shoring, bracing, underpinning, cribbing, pumping, and planking as required.
 - 2. Comply with applicable requirements of CCR, Title 8, Trench Construction Safety Orders.
 - 3. The bottoms of excavations shall be level, firm, undisturbed earth, clean and free from loose material, debris, and foreign matter.
 - 4. Excavate to the lines and grades indicated on the Contract Drawings.
 - 5. Excavations shall be supported and maintained by providing structural support of earth walls as specified in Section 31 50 00, Excavation Support and Protection, so that sides are stable and will not move. Excavations may be maintained by sloping cut faces where space permits, if calculations, sealed and signed by a civil or structural engineer currently registered in the State of California, show that the slopes are safe. Calculations shall consider all existing conditions, including adjacent traffic, construction loading, and other local effects.
 - 6. Limits of excavations shall allow for adequate working space for installing forms, wall waterproofing, and as required for safety of personnel. Cut excavations in solid rock accurately to the lines indicated on the Contract Drawings, or to the width of the ductbank or concrete encasement.
 - 7. Dewater excavation as specified in Section 31 23 19, Dewatering. Construct berms around excavations as required to prevent surface water and runoff from entering the excavation.
 - 8. Remove unstable bottom material. Remove large stones, debris, and compressible soils from excavation bottoms to a minimum depth of 12 inches. Where required to excavate to rock, it shall be understood to mean sound bedrock. Remove loose and unsound material.
 - 9. Except as otherwise indicated, preserve the material below and beyond the lines of excavations. Where an excavation is carried below the indicated grade, backfill to the indicated grade as herein specified.

10. Excavations for convenience of the Contractor shall be approved by the Engineer.
11. Place excavated material at a sufficient distance from edge of excavation so as not to cause cave-ins or bank slides, but in no case closer than 3 feet from the edge of excavations.
12. Unauthorized over excavations for footings and foundations shall be filled with lean concrete to indicated elevations.
13. Excavated earth material that is suitable for fill, backfill, or embankment shall be conditioned for re-use and properly stockpiled for later filling and backfilling operations as herein specified. Test, screen, and mix as necessary to meet specified requirements.

B. Rock Excavation:

1. Rock which cannot be broken up and removed by ripper equipment shall be excavated and removed by drilling and blasting. The use of explosives requires written approval of the Engineer as specified in General Conditions Article GC7.11.
2. Use pre-splitting to establish a shear plane in the rock along the cut periphery or proposed break lines to reduce overbreakage. Pre-split a periphery plane to the depth to be excavated prior to other blasting within the limits of that particular plane; except that the Contractor will not be required to pre-split to slopes flatter than one-to-one. Pre-split by drilling appropriately sized holes at intervals of not more than 3 feet, to the depth of the cut, along the plane of the proposed cut; load and stem such holes with an appropriate light charge explosive, and detonate all holes in the particular plane simultaneously.
3. If the depth of the cut is more than can be drilled from the top, an 18-inch offset will be allowed in the slope to begin succeeding drilling operations. The end result shall be a relatively smooth shear plane with localized irregularities which do not exceed 2 feet behind or 1 foot in front of the shear plane surface and which do not extend within the indicated lines of the excavation.
4. Where footings or foundations are to be placed on rock which is not horizontal, key the center of the foundation approximately 12 inches in depth throughout an area approximately equal to the dimensions of the column or footing to be placed on the rock, or the entire width of the slab, at not more than 10-foot intervals. Remove loose fragments, and clean and fill all seams with lean concrete.
5. Material excavated beyond or below the indicated cross section shall be at the Contractor's expense. Fill overbreakage to required invert with lean concrete at no additional expense to the District.
6. Leave the side slopes of rock cuts with reasonably uniform faces whether the excavation is carried beyond the specified side slopes or not. Remove all loose rock on cut slopes immediately after blasting. Sloped surfaces shall conform to

the typical section indicated or to natural cleavage planes, where these are compatible with the typical section.

7. Exposed rock faces shall be mapped by a Contractor-employed, California-registered geotechnical engineer or engineering geologist. If structural mapping indicates that unstable planes or other features are exposed which jeopardize the stability of the slope, the Contractor shall modify the slope as required.

3.07 EMBANKMENT CONSTRUCTION

- A. Construct embankments to lines, grades, and contours indicated, in layers as nearly uniform and horizontal as is consistent with the indicated finished contour and profile. Maximum thickness of the layers shall be 8 inches before compaction.
- B. Compact each layer to specified density for entire width of the embankment. Achieve required compaction by rolling with compaction equipment suitable for type and condition of the particular material. Roll in a longitudinal direction parallel to longest dimension, starting at outer edges and progressing toward the center.
- C. Moisture-condition embankment fill material as required to achieve its compaction to the specified density, within the tolerances specified herein.
- D. Do not compact material that contains excessive moisture. In such cases, scarify to the full depth of the layer having excessive moisture content and dry by reworking, mixing with dry materials, or other approved methods.
- E. Remove material that cannot be compacted to required density within specified tolerances, and replace with suitable material.
- F. Where pipes, culverts, or structures extend into embankments, construct embankment to at least 2 feet over and 10 feet on either side of the pipe, culvert, or structure location prior to excavation.
- G. Where fill is to be placed against hillsides or slopes steeper than 5 to 1 (horizontal to vertical), the existing slope shall be benched at least 6 feet horizontally into the hillside as the new embankment is placed in horizontal lifts.
- H. Do not commence final shaping until above specified requirements have been completed. Shape entire surface of the slopes of cuts and embankments to true grade, alignment, and cross section indicated. Leave cut slopes in rock with uniform surface, and remove all loose overhanging rock.

3.08 SUBGRADE PREPARATION

- A. Perform all cutting, blading, and shaping as required to cut and shape the sub grade to the grades and elevations indicated.
- B. Sub grade preparation includes fine grading, reworking as necessary, and preparation of cut, fill, or embankment upon which the structure and equipment

foundations, pipe, sub ballast, sub base, base, and pavement will be placed. Remove unsuitable sub grade material, such as weak or compressible soils.

- C. Scarify and mix entire surface of sub grade to a depth of at least 6 inches. Moisture-condition scarified sub grade to 3 percent above optimum moisture content. If sub grade stabilization material is required, incorporate it into the sub grade at this time.
- D. After the material has been thoroughly mixed and moisture-conditioned, accurately construct and fine grade the sub grade to indicated line, grade, and contour with high and low spots eliminated. Compact for full width to the specified density. Remove soft spots developed during working, fill with approved material, and re-compact.
- E. Finish sub grade to straightedge or template within specified tolerances with the finished surface bladed to a uniform, dense, smooth texture.

3.09 FOUNDATION PREPARATION

- A. Complete construction of the excavation support and dewatering systems prior to construction of structure and equipment foundations.
- B. Avoid disturbing bottom of excavation. If bottom is disturbed, restore and stabilize the bearing foundation with compacted pervious backfill material as specified herein.
- C. If material at bottom of the excavation is rock, remove loose material and roughly level the bearing foundation to indicated elevation. If the bottom contains occasional rock outcroppings or rock in only a portion of the area, remove such rock to a depth of 6 inches below indicated sub grade and backfill with lean concrete.
- D. Where unsuitable material is encountered at the elevations indicated for foundations, all soft, loose, or unsuitable material shall be removed. The area shall be scarified to a minimum depth of 12 inches, and the planned elevation shall be re-established by backfilling with structural backfill, moisture-conditioning, and compacting to a minimum dry density of 95 percent of the maximum laboratory dry density as determined in accordance with ASTM D1557. Where the exposed foundation consists of competent, undisturbed in-place soils, scarifying may be omitted.

3.10 SUBGRADE FILLING/RAISING GRADE

- A. Compacted fill for raising of sub grade to indicated elevation shall be constructed by approved methods. Fill material shall be spread in uniform lifts not exceeding 8 inches in uncompacted thickness. Fill material that does not contain sufficient moisture to compact properly shall be sprinkled with water; if it contains excess moisture it shall be aerated or permitted to dry to the proper water content. Fill material and water shall then be thoroughly mixed before being compacted. Each layer of spread fill material shall be compacted to the specified density.
- B. Control of fill shall consist of field inspection and testing to determine that each layer has been compacted to the required density and to ensure that optimum moisture is being obtained. Any layer or portion of a layer that does not attain the compaction

required shall be scarified and re-compacted until the required compaction is obtained.

- C. Spreading and compacting shall be performed as required to produce the required density and a uniform surface smooth and true to grade.

3.11 **COMPACTION**

- A. **Compaction Density:** Compact each layer of embankment, fill, and backfill material to not less than the indicated or specified compaction. Required compactions are defined as Class I and Class II, as follows:

1. **Class I Compaction:** 90 percent relative compaction as determined by ASTM D1557.
2. **Class II Compaction:** 95 percent relative compaction as determined by ASTM D1557.

- B. **Required Compactions:**

1. **Embankment or Fill where the Surface will be Bearing Foundation:** Class II for full depth. Where embankment construction exceeds 5 feet in depth, provide minimum Class I compaction below the top 2.5 feet.
2. **Fill Below Trackways and Pavements:** Class II for full depth. Where fill exceeds 3 feet in depth, provide minimum Class I compaction below the top 3 feet.
3. **Backfill around Structures:** Class I under top 12 inches; Class II for top 12 inches.
4. **Cut-and-Cover Backfill:** Class I to 36 inches above structure or utility; Class II for balance, with a minimum of Class II for top 12 inches.
5. **Original Ground or Cut Sub grade:** Except as specified in Articles 3.08 and 3.09 where original ground or cut sub grade, or fill less than 1 foot thick, will be sub grade or bearing foundation, scarify the surfaces and provide Class II compaction for at least 8 inches in depth. Include the following additional requirements:
 - a. Provide Class II compaction for original ground when such original ground is within 3.5 feet of top of rail profile or within 2.5 feet of finished pavement grade, for full width of trackway and pavement plus three feet on each side thereof.
 - b. Provide Class II compaction for top 6 inches of undisturbed original ground upon which embankments are to be constructed.
6. **Where not otherwise indicated or specified and where structures are not involved,** provide Class I compaction to minimize settlement.

3.12 BACKFILLING

- A. Use materials removed from site excavations if such material meets specified requirements.
- B. Backfilling is required around all substructures. Fill all abandoned vaults, shafts, airways, adits, holes, pits, and other voids.
- C. Place backfill in layers not to exceed eight inches of loose material, and compact each layer to specified density before the next layer is placed.
- D. Place backfill material in such manner that unbalanced horizontal loads will not be applied to a newly placed structure or portion of structure, utility, or pipeline. Do not backfill around portions of structures requiring backfill on only one side or on less than all sides, until the concrete has reached the specified 28-day strength to withstand the earth pressures on structures.
- E. When placing material for backfill around waterproofed structures, protect such structures and the waterproofing thereof with a shield when necessary to prevent displacement or injury by stones or other hard substances in the backfill.
- F. Do not backfill on or against structural concrete until the specified 28-day concrete strength has been attained.
- G. Complete backfill for end bents and abutments, including backfill for wingwalls, in accordance with the above specified time/strength limit. Step slopes behind abutments, unless otherwise indicated, to prevent backfill from acting as a wedge against the abutment. Provide drainage behind abutments and wingwalls as indicated.
- H. Do not use compaction equipment and methods that produce excessive horizontal or vertical earth pressures on structures. Excessive horizontal earth pressures are those in excess of at-rest earth pressures. Excessive vertical earth pressures are those in excess of overburden pressures.

3.13 FINISH GRADING

- A. Finish grade all areas to elevations and grades indicated. In areas to receive topsoil and landscape planting, finish grading shall be performed to a uniform 7 to 8 inches below the grades and elevations indicated.
- B. Place and spread stockpiled topsoil to a uniform thickness of 6 inches (approximately) in areas to receive topsoil and landscape planting. Place and spread to a uniform thickness approximately 1 inch below finish grades indicated.
- C. Coordinate with the requirements of Section 32 90 00, Planting.

3.14 FIELD QUALITY CONTROL

- A. Regulatory Requirements: In compliance with the California Building Code, Chapter 33 and Appendix Chapter 33, the Contractor's earthwork operations shall be performed under the observance and inspection of a Contractor-employed geotechnical engineer currently registered in the State of California, as follows:
1. Site preparation, cutting and shaping, excavating, filling, backfilling, and embankment construction shall be carried out under the inspection of the geotechnical engineer, who will perform appropriate field and laboratory tests, as determined by the geotechnical engineer, to evaluate the suitability of fill and backfill material, the proper moisture content for compaction, and the degree of compaction achieved. Fill or backfill that does not meet the specified requirements shall be removed or recompacted until the requirements are satisfied.
 2. Cutting and shaping, excavating, conditioning, filling, backfilling, and compacting procedures require approval of the geotechnical engineer as they are successively performed. Work found to be unsatisfactory or work disturbed by subsequent operations before approval is granted shall be corrected in an approved manner as approved by the geotechnical engineer.
- B. Density Tests: Compacted fill, backfill, and embankment shall be tested to verify compliance with specified requirements in accordance with ASTM D2922. Frequency of tests shall be in accordance with the Contractor's Quality Plan, but not less than the following:
1. Expansive Horizontal Areas: One test per 100 cubic yards, or fraction thereof, of fill or backfill placed.
 2. Confined Areas and Embankments: One test per every second lift of fill, backfill, or embankment placed.
- C. Compaction Tests: Tests for compaction shall be performed in accordance with test procedures specified in ASTM D1557, Method D, as applicable. Field-testing of soils or compacted fill in place shall be performed in accordance with applicable requirements of ASTM D2922.
- D. Moisture Content Tests: Compacted fill, backfill, and embankment shall be tested to verify compliance with specified requirements in accordance with ASTM D3017. Minimum frequency of tests shall be as specified above for density tests.

END OF SECTION 31 00 00